Remarks

Applicant has amended page 1 of the specification to add a reference to the parent application.

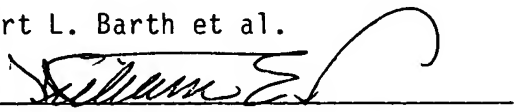
Applicant has also cancelled claims 1-25. Remaining claims 26-53 comprise Examiner Everhart's Group III set of claims set forth in the restriction requirement made in the Office Action mailed August 1, 2001, in the original grandparent application.

A Claims Listing setting forth all claims in this application is attached hereto.

It is believed that this divisional application is now in condition for examination on the merits of claims 26-53. Favorable action is accordingly solicited.

Respectfully submitted,

Kurt L. Barth et al.

By 

William E. Hein
Patent Attorney #26,465

March 24, 2004
(970) 667-6741
Loveland, Colorado

Claims Listing:

Claims 1-25 (canceled)

26. (original) Apparatus for transporting substrates within a vacuum chamber, the apparatus comprising:

a pair of spaced apart parallel metal belts positioned within the vacuum chamber;

a translator for bidirectionally moving the pair of metal belts in concert; and

a plurality of aligned, periodically-spaced tabs positioned on an outer surface of each of the metal belts for retaining a plurality of the substrates in fixed positions spanning the metal belts.

27. (original) Apparatus for transporting substrates within a vacuum chamber as in claim 26, wherein the vacuum chamber includes front and rear openings through which the pair of metal belts and the substrates pass, extending outside said front and rear openings, the apparatus further comprising:

a clearance distance between each of the substrates and the front and rear openings so as to permit motion of the substrates while at the same time restricting air leaks, to thereby maintain a desired level of vacuum in the chamber.

28. (original) Apparatus for transporting and processing a plurality of substrates by exposing them to heating, film deposition or vapor treatment within a vacuum chamber, the apparatus comprising:

a plurality of heated pockets positioned in proximity to and in correspondence with each of the plurality of substrates such that a clearance distance between a surface of each of the substrates and the corresponding one of the heated pockets is minimized so as

to permit motion of the substrates while restricting vapor leaks from the heated pockets; and

a transporter for moving the substrates from one heated pocket to the next.

29. (original) Apparatus as in claim 28, wherein the transporter comprises:

a pair of spaced apart parallel metal belts positioned within the vacuum chamber;

a translator for bidirectionally moving the pair of metal belts in concert;

a plurality of aligned, periodically-spaced tabs positioned on an outer surface of each of the metal belts for retaining a plurality of the substrates in fixed positions spanning the metal belts; and

a controller, coupled to said translator, for indexing the belts incrementally to move each of the substrates from one heated pocket to another.

30. (original) Apparatus as in claim 28, wherein a selected one or more of the heated pockets includes a high voltage pin coupled to a source of D.C. voltage for creating a plasma within the selected one or more of the heated pockets.

31. (original) A method for fabricating semiconductor layers of a photovoltaic cell, all of the steps of which are carried out in a single vacuum chamber at a constant vacuum level, the method comprising the steps of:

providing, in the vacuum chamber, a substrate having one or more layers of an n-type transparent conductive oxide upon which the photovoltaic cell is to be fabricated;

heating the substrate to a desired temperature in the vacuum chamber;

depositing one or more layers of p-type IIB/VIB semiconductor material onto a surface of the substrate in the vacuum chamber;

treating the one or more layers of n-type transparent conductive oxide and p-type IIB/VIB semiconductor material with a halogen containing substance in the vacuum chamber; and

forming an ohmic contact on the treated one or more layers of p-type IIB/VIB semiconductor material in the vacuum chamber.

32. (original) A method as in claim 31, wherein the p-type IIB/VIB seimiconductor material comprises cadmium telluride.

33. (original) A method as in claim 31, wherein the halogen containing substance comprises cadmium chloride.

34. (original) A method as in claim 31, wherein the step of treating the one or more layers of n-type transparent conductive oxide and p-type IIB/VIB semiconductor material with a halogen containing substance comprises:

exposing the one or more layers of n-type transparent conductive oxide and p-type IIB/VIB semiconductor material to the vapor of the halogen containing substance for a predetermined time at a specific temperature; and

annealing the one or more layers of n-type transparent conductive oxide and p-type IIB/VIB semiconductor material that have been previously exposed to the vapor of the halogen containing substance.

35. (original) A method as in claim 34, wherein:

the temperature at which the one or more layers of n-type transparent conductive oxide and p-type IIB/VIB semiconductor material are exposed to the vapor of the halogen containing substance is suitable for depositing a film of the halogen containing substance onto the one or more layers of p-type IIB/VIB semiconductor material; and

the step of annealing the one or more layers of n-type transparent conductive oxide and p-type IIB/VIB semiconductor material is performed at a temperature suitable for treating the one or more layers of n-type transparent conductive oxide and p-type IIB/VIB semidconductor material and removing the film of the previously deposited halogen containing substance.

36. (original) A method as in claim 31, wherein the step of forming an ohmic contact on the treated one or more layers of p-type IIB/VIB semiconductor material comprises depositing a metal compound onto the treated one or more layers of p-type semiconductor material and then annealing the treated one or more layers of p-type IIB/VIB semiconductor material.

37. (original) A method as in 36, wherein the metal compound is a metal salt selected from the group comprising the salts of copper, silver, gold, tin, lead, antimony and mercury.

38. (original) A method as in claim 36, wherein the metal compound is an organometallic compound selected from the group comprising the organometallic compounds of copper, silver, gold, tin , lead, antimony, and mercury.

39. (original) A method as in claim 31, further comprising the step of depositing an anti-reflective layer on an opposite surface of the substrate in the vacuum chamber.

40. (original) A method for fabricating semiconductor layers of a photovoltaic cell, all of the steps of which are carried out in a single vacuum chamber at a constant vacuum level, the method comprising the steps of :

providing, in the vacuum chamber, a substrate upon which the photovoltaic cell is to be fabricated, the substrate having one or more layers of n-type transparent conductive

oxide thereon and one or more layers of n-type IIB/VIB semiconductor material on top of the one or more layers of n-type transparent conductive oxide;

heating the substrate to a desired temperature in the vacuum chamber;

depositing one or more layers of p-type IIB/VIB semiconductor material onto a surface of the substrate in the vacuum chamber;

treating the one or more layers of n-type IIB/VIB semiconductor material and p-type IIB/VIB semiconductor material with a halogen containing substance in the vacuum chamber; and

forming an ohmic contact on the treated one or more layers of p-type IIB/VIB semiconductor material in the vacuum chamber.

41. (original) A method as in claim 40, wherein the n-type IIB/VIB semiconductor material comprises cadmium sulfide.

42. (original) A method as in claim 40, wherein the p-type IIB/VIB semiconductor material comprises cadmium telluride.

43. (original) A method as in claim 40, wherein the halogen containing substance comprises cadmium chloride.

44. (original) A method as in claim 40, wherein the step of treating the one or more layers of n-type IIB/VIB semiconductor material and p-type IIB/VIB semiconductor material with a halogen containing substance comprises:

exposing the one or more layers of n-type IIB/VIB semiconductor material and p-type IIB/VIB semiconductor material to the vapor of the halogen containing substance for a predetermined time at a specific temperature; and

annealing the one or more layers of n-type IIB/VIB semiconductor material and p-type IIB/VIB semiconductor material that have been previously exposed to the vapor of the halogen containing substance.

45. (original) A method as in claim 44, wherein:

the temperature at which the one or more layers of n-type IIB/VIB semiconductor material and p-type IIB/VIB semiconductor material are exposed to the vapor of the halogen containing substance is suitable for depositing a film of the halogen containing substance upon the one or more layers of p-type IIB/VIB semiconductor material; and

the step of annealing the one or more layers of n-type IIB/VIB semiconductor material and p-type IIB/VIB semiconductor material is performed at a temperature suitable for treating the one or more layers of n-type IIB/VIB semiconductor material and p-type IIB/VIB semiconductor material and removing the film of the previously deposited halogen containing substance.

46. (original) A method as in claim 40, wherein the step of forming an ohmic contact on the treated one or more layers of p-type IIB/VIB semiconductor material comprises depositing a metal compound onto the treated one or more layers of p-type IIB/VIB semiconductor material and then annealing the treated one or more layers of p-type IIB/VIB semiconductor material.

47. (original) A method as in claim 46, wherein the metal compound is a metal salt selected from the group comprising the salts of copper, silver, gold, tin, lead, antimony, and mercury.

48. (original) A method as in claim 46, wherein the metal compound is an organometallic compound selected from the group comprising the organometallic compounds of copper, silver, gold, tin , lead, antimony, and mercury.

49. (original) A method as in claim 40, further comprising the step of depositing an anti-reflective layer on an opposite surface of the substrate in the vacuum chamber.

50. (original) A method as in claim 40, further comprising the step of treating the one or more layers of n-type IIB/VIB semiconductor material with a halogen containing substance prior to depositing the one or more layers of p-type IIB/VIB semiconductor material.

51. (original) A method as in claim 50, wherein the halogen containing substance comprises cadmium chloride.

52. (original) A method as in claim 50, wherein the step of treating the one or more layers of n-type IIB/VIB semiconductor material with a halogen containing substance comprises:

exposing the one or more layers of n-type IIB/VIB semiconductor material to the vapor of the halogen containing substance for a predetermined time at a specific temperature; and

annealing the one or more layers of n-type IIB/VIB semiconductor material that has been previously exposed to the vapor of the halogen containing substance.

53. (original) A method as in claim 50, wherein:

the temperature at which the one or more layers of n-type IIB/VIB semiconductor material is exposed to the vapor of the halogen containing substance is suitable for

depositing a film of the halogen containing substance onto the one or more layers of n-type IIB/VIB semiconductor material; and

the step of annealing the one or more layers of n-type IIB/VIB semiconductor material is performed at a temperature suitable for treating the one or more layers of n-type IIB/VIB semiconductor material and removing the film of the previously deposited halogen containing substance.